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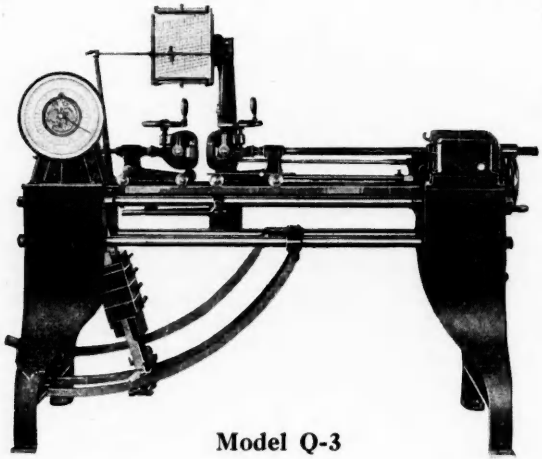

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TEXTILE RESEARCH

Publication of

United States Institute for Textile Research, Inc.
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The Textile Foundation, Inc.

Warp Sizing Group to Meet

THE Administrative Committee for the research on the warp sizing of spun rayon and blends of cotton-spun rayon (Carl R. Harris, Chairman, Dean Thomas Nelson and Dr. W. E. Yelland) are submitting a questionnaire to subscribers for the purpose of learning whether the original program for the study needs revision. After receipt of replies, the subscribing group will meet at North Carolina State College Textile School, where the research is to be conducted, to complete plans, view the laboratories and equipment provided for it, and to meet the research associate who has been tentatively engaged to direct the study. The latter's engagement is "tentative" until approved by subscribers, and also until additional money needed to complete the financing is subscribed, but he is the unanimous choice of the committee and the Chairman of the Institute's Research Council.

Manufacturer to Direct Study

The research associate selected by the committee to direct this study is not a scientist, as have been the men who have directed prior Institute researches, but a practical manufacturer of long and varied experience and demonstrated ability. In the planning and conduct of the work he will have the advice and co-operation of the Administrative Committee and a group of chemists and physicists, including Dr. Yelland, who directed the Institute's previous warp sizing study, Chairman Appel of the Research Council and certain members of the staff of North Carolina State College. They will be able to provide most of the basic scientific knowledge that will be needed, much of which, together with suitable research techniques, are results of the Institute's completed research on the warp sizing of filament viscose rayon. The research associate will have assistants for laboratory work, and can be depended upon to so direct the study as to secure the desired applied results as soon as possible. Furthermore, he will be able to report the results in non-scientific, or easily understandable, language.

* * *

New Color Fastness Specifications

A notable result of co-operative effort is contained in the formal joint application presented by the National Association of Finishers of Textile Fabrics and the American Association of Textile Chemists and Colorists to the National Bureau of Standards for the adoption by the latter body of new color fastness standards embodied in the report of the joint bodies entitled "Color Fastness Specifications for Dyed or Printed Cottons or

Linen Piece or Woven Materials.'' The application has the endorsement of 18 other organizations and companies. If adopted the new specifications will displace or require amendment of C. S. 59–39 of the Bureau.

* * *

Color Council's Meeting Program

THE annual meeting of the Inter-Society Color Council will be held jointly with the Optical Society of America and the American Physical Society, Feb. 21–24, in New York City, and members of the Institute interested in color will be welcome to attend any of the meetings. The technical session at the Roosevelt Hotel, 2 P. M., Feb. 21, will be co-sponsored by the Technical Association of the Pulp and Paper Industry, and devoted in large part to color instruments used in that industry. A notable feature of the joint meetings to be held at Columbia University, Feb. 23–24, will be a symposium on ''Optical Methods for the Study of Molecular Structure.'' For program and tickets address (enclosing self-addressed stamped envelope) Inter-Society Color Council, P. O. Box 155, Benj. Franklin Station, Washington, D. C.

* * *

Evening Textile Courses at Columbia University

H. R. Mauersberger, who for 14 years has been in charge of the evening textile courses at Columbia University, New York City, announces the following courses for the Spring Session of 1940, registration for which begins Feb. 5: ''Identification, Analysis and Testing of Textiles (Advanced),'' G. R. Turner; ''Converting of Rayon and Spun Rayon Fabrics,'' and ''Cotton Goods Converting,'' H. R. Mauersberger; ''Woolen and Worsted Manufacture,'' Werner von Bergen; ''Advanced Woven and Printed Fabric Design,'' William H. Arlt. These and a course on ''Textile Chemistry'' extend for a period of 15 weeks and require no entrance examination. All inquiries should be addressed to the Director of University Extension, Columbia University. Mr. Mauersberger also announces the addition of a new course on the subject of ''Merchandising and Marketing of Textiles'' to be given next Fall by Dr. S. J. Kennedy, director of market research for Pacific Mills. The course will consist of 15 lectures and will be given on Tuesday evenings. For further information address the Registrar of Columbia University.

Personals

John G. Jackson, who has been vice-chairman of the board of directors of American Viscose Corp., has been elected chairman, succeeding Samuel A. Salvage who retired on Dec. 31. William H. Brown, formerly secretary and assistant treasurer, was elected treasurer, and William B. Olmstead, Jr., sales manager of the corporation, was elected a director.

* * *

Warner Eustis, director of the research department of the Kendall Company, Boston, Mass., has been designated as the company's representative for its membership in the Industrial Research Institute which is affiliated with the National Research Council.

(Continued on Page 176)

The Influence of Electrolytes on the Ballo-Electric Effect

By P. H. BURDETT,* J. E. MAGOFFIN* and F. K. CAMERON

A Textile Foundation Publication

Introduction

THE potential difference arising at the interface between two phases has long been of interest to the chemist and physicist. In previous papers [9, 10] Burdett has discussed this phenomenon with reference to the gas-liquid interface formed when a gas is bubbled through the liquid. In this paper the phenomenon is studied for the liquid-gas interface formed by spraying a liquid into a gas from an atomizer.

In 1914 J. J. Nolan [25, 26, 27, 28, 29, 30, 31, 32, 33, 34] published his first paper on the potential difference developed at the gas-liquid interface formed by spraying. He was actively engaged in this work for ten years during which time he was joined by his brother, P. J. Nolan,[21, 22, 23, 35, 36] and by various other workers, among them Gill,[33] Enright,[32] Harris,[24] and McClelland.[21, 22, 23] They first used a tray similar to the one used in our later experiments. However, they soon became interested in the nature of the electrical carriers produced and their later work was based on the trapping of these carriers in a Zeleny apparatus where their mobilities could be studied. Based on the claim that the study of the net charge produced is not so informative as the study of the individual negative and positive carriers, all recent workers have studied the mobilities and nature of these carriers. J. J. Nolan and Gill [33] reported no reversal of charge in the case of sodium chloride in concentrations up to 2.5 N. This interesting fact has been confirmed in our work.

J. J. Nolan and Enright [32] also suggested the idea of measuring droplet sizes by trapping the droplets in oil. We have adopted this idea in our work.

There have been many other workers and it will be impossible to mention them all here. The work of Buhl [4, 5, 6, 7, 8] stands out, however, both because of his thoroughness and because of his excellent review of the work up to 1932.

Malarski [24] published a paper in 1934 on electrification by spraying onto a target. His work is particularly interesting in view of the results we obtained in our experiments and we shall mention his work later.

Burkhardt [11] has employed liquid droplets to charge a condenser for the production of high potentials and reports potentials as high as 420 K. V.

None of these workers has chosen to study systematically the effect of added electrolytes as we have and so none has been led to the theoretical considerations to which we have been led by our results. However, a dis-

* Investigators for the Textile Foundation, working under the direction of Dr. Frank K. Cameron at the University of North Carolina.

cussion of these considerations must wait until our own results have been described.

The common characteristic of most early work was the fact that it was not carried to completion. Usually enough experimental work was done to justify a few general conclusions and there the subject was dropped. This was not so surprising when a few months of work had shown how difficult were the experimental techniques and how many variables must be controlled. It became very apparent that, if we were to accomplish more than our predecessors, we must limit ourselves to studying a few carefully controlled conditions.

Experimental

The apparatus used in the experimental work was based on that previously used by Nolan and Gill.[33] As finally developed by us it can probably best be considered under five headings, namely: (a) the air supply; (b) the sprayer; (c) the tray; (d) the electrometer; (e) the slide. These will be considered in order.

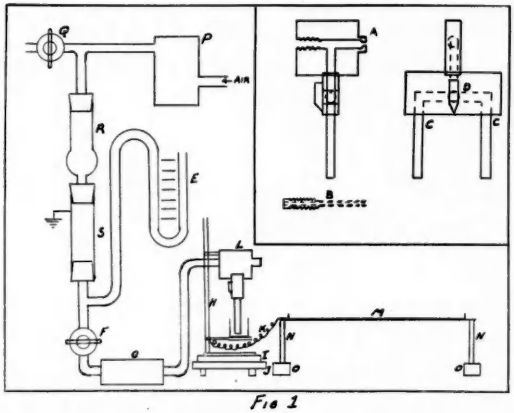

Fig 1

(a) *The Air Supply.*—A Nelson pump supplied compressed air and was adjusted with a light spring which would just maintain a pressure of 30 cm. of mercury when the sprayer was in operation. From this pump the air passed through a buffer tank (Fig. 1, P) to smooth any surges caused by the operation of the pump. Between the pump and the buffer tank was an escape valve (Q) by which the pressure could be released from the system. The air passed next to a drying tube (R) filled with fine glass wool to remove any entrained oil from the pump. Next was a brass tube (S) grounded and filled with brass and aluminum shavings to remove any charges which might be present in the gas. An open tube manometer (E) was inserted next and then another valve (F) which controlled the air supply to the spray nozzle. The air then passed through a hard rubber tube (G) 6.5″ long, 0.6″ inside diameter which was supported near the end next to the pump. The hard rubber tube was connected to the atomizer by a rubber

tube without further support. This tube was 0.3″ inside diameter and about 2′ long. Together with the hard rubber tube it formed a satisfactory insulating connection between the air supply and the sprayer.

(b) *The Spray Nozzle.*—The sprayer or atomizer was mounted on a ring stand (Fig. 1, H) which rested in turn on a block of wood (I) coated on all sides with a thick coat of ceresin. This block was in turn supported on a wooden "table" (J) of which the four legs were sticks of sealing wax about 1.5″ long. The ring stand was connected to the tray to nullify any charge which the spray might acquire in passing through the nozzle. The ring stand also carried a support on which the beakers could be raised into place under the atomizer (K).

The sprayer (L) was constructed entirely of brass. The nozzle itself had a slightly domed face, in the center of which was a 0.036″ hole. Air entered through a central tube from the back. This tube was 0.125″ outside diameter and fitted snugly into a seat drilled in the back of the nozzle (Fig. 1, A) whereby the hole in the nozzle was brought exactly in line with the 0.020″ hole in the central tube (B). The tube was inserted in the back of the atomizer by means of a screw thread which allowed the tube to be adjusted in its seat to accommodate various spraying pressures.

The front of the tube was provided with six accurately cut 0.015″ slots tangent to an imaginary circle 0.05″ in radius on the end of the tube. These slots made an angle of 40° with the long axis of the tube and were cut in a mill with the tube so inclined that the slots varied in depth from nothing in the center to 0.1″ on the side of the tube. The solution, rising into the chamber surrounding the central tube, was forced to travel through these slots since the side of the tube fitted snugly against the seat and in this way a spiral motion was imparted to the liquid which tended to produce finer droplets when the liquid left the nozzle than could be produced otherwise.

Two 3.5″ pieces of 0.25″ brass tube (C, C), 1.5″ apart dipped into the two beakers mentioned above and lead, by way of a three way stopcock (D) to the chamber around the central tube of the atomizer. This arrangement allowed a shift from one liquid to the other by simply turning the stopcock.

(c) *The Tray.*—The collecting tray (Fig. 1, M) consisted of a galvanized iron pan 20″ × 42″ × 1″ stiffened on the bottom by two pieces of light angle iron. Considerable difficulty was encountered in insulating the tray from the table on which it rested but after many trials a successful method was developed. From four holes drilled and tapped in the ends of the angle irons, 0.25″ steel rods (N, N) 9″ long lead to brass plates 2.5″ square which were imbedded in blocks of ceresin (O, O) 3.5″ × 3.5″. The rods were also coated with ceresin throughout their length. The blocks of ceresin provided "body" resistivity while the ceresin coated rods provided a long narrow surface which afforded good resistance to surface leakage.

Even with these precautions, it was impossible in the high humidity of damp weather to keep the tray adequately insulated. After many attempts a method was devised to avoid the difficulty of moisture collecting on the surface of the ceresin wax. A box consisting of four sides and a top was made for each leg. The sides were about 5″ long so that the box fitted easily around the ceresin block. The boxes were about 9.5″ high and thus covered almost all of the steel legs. A slot in the top and a removable side allowed each box to be slipped over the leg it was to protect. The removable side held, on its inner side, a thin basket of copper wire screen which was filled with granular anhydrous calcium chloride. When the box was in

place, air could enter only by the slit in the top and the calcium chloride effectively kept the air inside dry and hence also the ceresin surfaces.

(d) *The Electrometer.*—The electrometer was of the FP–54 vacuum tube type and employed a Westinghouse RH–507 tube. The apparatus was housed in an aluminum case which was grounded. The working battery was kept several feet away and was connected to the electrometer by means of a shielded cable which was also grounded.

The tray was connected to the electrometer tube by a fine, silk-covered copper wire supported where necessary by ceresin blocks hung in turn from silk threads.

A 2500 Type R galvanometer was used which had an internal resistance of 500 ohms and a sensitivity of 0.000096 M.A./mm. Between the galvanometer and the electrometer was an 100,000 ohm Ayrton Shunt and across the poles of the galvanometer was a variable resistance in the form of a decade box usually set at 22,000 ohms.

(e) *The Slide.*—The slide spanned the tray on its long dimension and was thus about 46″ long including side trucks. It was 4″ wide and was provided with a long slot in the front edge in which microscope slides could be mounted over the tray. The trucks were of wood and were 6″ long. They were fitted with brass rollers on the top and sides and smooth motion of the slide was thus insured.

The tracks on which the slide ran were of wood and extended far enough on either side of the tray so that the slide was completely out of the spray zone before and after passing through the spray. The total length of the tracks was 40″.

The slide, having been mounted on one side of the tray, could be pulled to the other side by means of strings attached to a 1/20 H.P. motor and so arranged as to give uniform pull on each side of the slide.

Microscope slides were coated with a smooth coat of an oil of such viscosity that droplets of water falling on it would be retained without serious deformation and yet would sink only slowly in the oil. Such an oil was prepared by heating together mineral oil and white petroleum jelly in proportions of about 5:2 or until the right consistency was obtained. A drop of this on a microscope slide could be heated gently over an electric light bulb and would flow into an even coating which, on cooling, would set enough to remain in place.

A slide with such a coating would, when drawn through the spray on the slide, retain a sample of spray, representative of that falling at that particular distance from the nozzle.

A stop on the track halted the slide in such a position that the microscope slide was exactly in the field of a microscope camera previously placed beside the tray. To insure clear focus, one half of the microscope slide was covered with a "tent" of tinfoil and the slide was pulled through the spray into the field of the camera. The microscope was focused after which the "tent" was removed and the unused portion of the microscope slide was moved into the field of the camera. The slide was then returned to the opposite side of the tray and the focusing plate of the camera was replaced by the sensitized plate. When the slide was again drawn through the spray, the camera was ready and a photograph could be taken within 3 seconds of the time the spray hit the layer of oil. This rapid timing was necessary since the smallest droplets were only a fraction of a micron in diameter and did not sink in the oil but stayed on the surface where they evaporated very

rapidly. Also the larger drops settled more rapidly than the smaller ones so that within a few seconds of the time they hit it was impossible to get a clear photograph of all the droplets.

Since the magnification was known and since the slide moved at the same speed each time, it was possible by means of calculations, which will be explained in detail later, to determine the average ratio of surface to volume of the spray. This was an indication of the extent of pulverization obtained.

Although the apparatus has been described in order it must be remembered that all controls were grouped together so that the operator could reach them all without having to move. This was necessary since any movements would unbalance the sensitive electrometer. The controls thus grouped together were the stopcock on the sprayer, the valve admitting air to the sprayer, the escape valve, the pump motor switch, the electrometer controls and the Ayrton Shunt.

Procedure

The procedure for using this apparatus was evolved as the apparatus itself was evolved and, as in the case of the apparatus, only the final form will be discussed.

The observer was grounded by means of a metal wrist band (watch bracelet) connected with the case of the electrometer. This precaution reduced the effect of bodily movement on the part of the observer. Redistilled water was placed in the beaker on one side of the atomizer and the solution to be studied was placed on the other side. Needless to say, all the apparatus had to be carefully cleaned since surprisingly small amounts of impurities lead to large deviations in results.

The compressor was started and, when the desired pressure has been reached, the valve (F) was turned on and the sprayer was operated on distilled water until the spray had become steady and the tray was quite wet. The valve (F) was then turned off and the escape valve (B) was opened until the pressure had fallen to about 20 cm. less than the spraying pressure. The escape valve was then closed and, while the compressor was building the pressure up again, the electrometer was balanced in the usual way. When the spraying pressure was reached as indicated on the manometer, the valve (F) was turned on and the spray was allowed to fall on the tray until there was no further deflection of the galvanometer. The valve (F) was then closed, the escape valve opened, and the Ayrton Shunt was returned to the zero position. When the pressure had dropped about 20 cm., the escape valve was closed and the process was repeated.

Four or five determinations usually sufficed to fix the value of the reading for pure water. If this was reasonably high (5.5 or higher) the stopcock on the atomizer was turned to connect the solution under investigation and readings were taken on it in the same way. If the readings for water were very low some measures were taken to raise them since the readings for the salt solution would be still lower and it would be difficult to make accurate measurements. Usually the sensitivity of the electrometer could be increased by increasing the resistance across the galvanometer. However, when the critical damping resistance of the galvanometer was exceeded, the balance of the electrometer was destroyed. When this happened it was usually necessary to replace the insulation of the supports of the tray and on the outer surface of the electrometer tube.

When the desired number of readings had been taken, distilled water was substituted for the salt solution and the atomizer was rinsed out by spraying distilled water for several minutes. Whenever the readings for the salt solution were not constant, readings were again taken for the distilled water as a check against those taken at the beginning of the experiment.

Results

The first liquid to be studied was, of course, distilled water. A distilled water was used which had a conductivity of about 1.9×10^{-6} ohms.$^{-1}$ cm.$^{-1}$ This is the distilled water referred to in all subsequent experiments.

When the apparatus was finally assembled in its present form, 36 determinations were made with distilled water and they gave a mean value of 10.05 which was henceforth accepted as the standard for pure water to which all readings were weighted.

The probable accuracy of the readings in this and all subsequent determinations was calculated in the following way. The individual readings (in the case of salt solutions) were weighted by the factor $10.03/x$ where x is the mean value for pure water under the conditions of the experiment as indicated by the preliminary determinations with distilled water. The mean of the weighted readings was then taken as the correct value and the deviations of the individual readings were calculated without regard to sign. The probable average error was then determined by the common procedure of dividing the sum of the deviations by the product of the number of determinations and the square root of the number of determinations. The probable accuracy was then found by dividing the probable average error by the accepted correct value.

These calculations are illustrated in Table I for the sample case of 0.00032 M KCl.

The lower the readings the greater was the effect of outside disturbances on the electrometer and also the greater was the error introduced in reading the galvanometer. Hence the accuracy demanded was less than in the higher readings. With one exception the accuracy for readings below 4.0 was always less than 2.7% and for readings above 4.0 it was always less than 1.45%. Usually the probable accuracy was well within these limits of tolerance. It should be pointed out that the probable accuracy has no significance beyond a rough indication of the reproducibility of the results and is no indication of their precision.

Since experience had shown that small amounts of impurities might have great effect, all chemicals used were from previously unopened bottles of C. P. chemicals.

The salts were weighed accurately on an analytical balance and were placed in solution in 50 or 100 cc. volumetric flasks. From these the required amount was removed with an accurate pipette and was diluted to 500 cc. in a volumetric flask in which it was kept until used.

No serious difficulty was encountered until we attempted measurements of caesium nitrate using a sample of recovered salt which had been made by students several years ago. This was recrystallized before use. The readings obtained, however, were erratic and checks could not be obtained for successive solutions of the same concentration. This difficulty disappeared when C. P. caesium nitrate was obtained.

The next difficulty came when we started work with calcium chloride. There was apparently some aging effect in this case and solutions made

up for several hours invariably gave lower negative readings than new solutions and in several cases they changed so far as to give positive readings. This difficulty was never satisfactorily met, but we had some success when fresh solutions were made up before each series of determinations. The results obtained in this way fitted closely with what we predicted from theoretical considerations to be discussed later so we have accepted them tentatively. The same difficulty was encountered to a less degree with the other divalent elements, barium and magnesium, but there was no trouble with either the mono- or trivalent elements. No explanation for this has been

TABLE I

30 cm. pressure. 0.00032 M KCl. 30 cm. fall.

	Solution	Reading	Corrected Reading	Deviation
1.	H_2O	7.9		
2.	"	7.5		
3.	"	7.8		
4.	"	7.2		
5.	"	7.7		
6.	"	7.5		
7.	0.00032 M KCl	2.0	2.64	.16
8.	"	2.1	2.77	.03
9.	"	1.9	2.51	.29
10.	"	2.0	2.64	.16
11.	"	1.8	2.38	.42
12.	"	2.2	2.90	.10
13.	"	2.2	2.90	.10
14.	"	2.2	2.90	.10
15.	"	1.8	2.38	.42
16.	"	2.0	2.64	.16
17.	"	2.3	3.03	.23
18.	"	2.3	3.03	.23
19.	"	2.1	2.77	.03
20.	"	2.3	3.03	.23
21.	"	2.1	2.77	.03
22.	"	2.3	3.03	.23
23.	H_2O	8.1		
24.	"	7.5		

Conversion Factor, 1.32. Mean of determinations, 7–22, 2.77. Sum of deviations, 2.92. Probable average error, .045. Probable accuracy, 1.59%.

found, although the experience of erratic behavior among the compounds of the divalent elements is by no means peculiar to this work.

In all cases a spraying pressure of 30 cm. of Hg was used and the atomizer was placed 30 cm. above the level of the tray.

Table I shows the method of recording data and the calculations involved in the determinations of the probable accuracy. Table II lists the mean values of the series of determinations run to date. Except where noted, 16 determinations were run in each series.

By means of the slide mentioned previously, samples of the spray were photographed to allow a study of the droplet size. The calculations involved are shown in Table III. The droplets appearing on each plate were

tabulated according to size. The total volume and total surface for all the droplets of each size were then calculated. From these values the ratio of the total volume to total surface area of all the droplets could be determined. This is assumed to represent an average for all the drops sprayed. By determining this value for each set of conditions it is possible to determine whether the degree of dispersion has been changed and, if so, what the effect of this change is on the electrification.

It must be remembered that a considerable part of the electric charge is probably carried on particles too small to be photographed by these methods and that therefore the amount of information to be obtained in this way is limited.

It has been found that the addition of solution in the concentrations

TABLE II

Summary of Results

Salt	Cation Molarity	Water Obs.	Conversion Factor	Salt Obs.	Corrected Value
NaCl	3.45×10^{-5}	−9.10	1.105	−6.99	−7.72
	6.9	9.10	1.105	5.62	6.20
	13.8	9.11	1.10	4.45	4.92
	24.2	16.54	.607	5.70	3.46
	34.5	21.48	.468	6.42	3.00
	48.0	15.40	.653	3.55	2.32
	69.0	12.31	.815	1.59	1.29
	137.0	20.75	.484	2.64	1.27
	1370.0	18.35	.548	1.42	.78
	17150.0	15.87	.634	1.22	.774
$NaNO_3$	4.0	8.92	1.12	7.14	8.02
	8.0	10.10	.999	6.78	6.75
	16.0	10.10	.999	5.06	5.03
	24.0	10.38	.967	4.19	4.05
	32.0	10.53	.953	3.86	3.68
	72.0	8.82	1.14	1.06	1.20
NaOAc	1.0	8.33	1.20	9.67 B	11.70
	4.0	8.24	1.22	7.54	9.17
	8.0	7.97	1.26	6.11	7.68
	32.0	7.39	1.36	3.60 D	4.88
NaI	4.0	7.23	1.39	6.34 B	6.80
	16.0	7.28	1.39	4.34 B	5.99
	32.0	7.44	1.35	3.26 B	4.41
NaBr	4.0×10^{-5}	7.45	1.35	6.31 B	8.50
	16.0	7.45	1.35	4.16 B	5.60
	32.0	7.45	1.35	3.30 B	4.45
Na_2SO_4	4.0	5.70	1.76	4.77 B	8.40
	24.0	7.12	1.41	3.06	4.32
KCl	2.0	8.05	1.25	5.67	7.10
	4.0	8.12	1.24	4.66	5.77
	32.0	7.66	1.31	2.11	2.76
KBr	5.0	8.26	1.22	6.09 B	7.40
KI	5.0	5.70	1.97	3.82 B	7.51

Summary of Results–*Continued*

Salt	Cation Molarity	Water Obs.	Conversion Factor	Salt Obs.	Corrected Value
LiCl	4.0	−9.70	1.04	−7.36	−7.61
	16.0	9.62	1.05	3.98	4.16
	32.0	9.75	1.03	2.22	2.28
$LiNO_3$	4.0	6.30	1.60	4.96	7.93
	16.0	5.94	1.69	2.57	4.34
	32.0	9.62	1.05	2.52	2.64
$CsNO_3$	1.5	7.28	1.38	5.50	7.59
	3.0	9.04	1.11	5.81 C	6.46
	9.0	8.52	1.18	4.46	5.26
	15.0	8.06	1.25	3.45	4.30
	27.0	8.98	1.12	3.03	3.39
KNO_3	4.0	8.94	1.12	6.47	7.26
	16.0	6.93	1.45	3.14	4.54
	32.0	8.38	1.20	3.14	3.76
$CaCl_2$	2.0×10^{-5}	5.62	1.78	4.56 B	8.15
	32.0	7.47	1.36	1.34 B	1.82
$Ca(NO_3)_2$	4.0	4.72	2.13	3.44 B	7.32
$BaCl_2$	2.0	6.98	1.44	4.25 B	6.12
	4.0	6.66	1.51	3.12 B	4.70
	20.0	8.78	1.14	1.67	1.91
$MgCl_2$	2.0	6.82	1.47	5.42 B	8.00
	4.0	8.42	1.19	5.16 B	6.16
	16.0	6.66	1.51	1.40 B	2.13
$AuCl_3$	1.16	8.26	1.22	3.66	4.45
	2.94	8.32	1.21	2.84	3.42
	5.88	8.62	1.16	2.09	2.42
$CrCl_3$	2.0	8.54	1.18	3.08 B	3.62
	4.0	7.50	1.34	1.95 B	2.61
	10.0	8.60	1.17	0.84 B	0.98
	60.0	8.36	1.20	1.41 A	1.69

A, 7 determinations. B, 10 determinations. C, 14 determinations. D, 25 determinations.

used in these experiments does not change the drop size materially. The values for the ratio of surface area to volume were: water, 681.3 sq. cm./cc.; 0.017 M NaCl, 668 sq. cm./cc.

Discussion of Results

The first salt studied was sodium chloride and, after determinations had been made for about four concentrations, it became obvious that they would fall on a smooth curve if the charge in scale units was plotted against the concentration. When ten concentrations had been studied, it was still possible to draw a smooth curve through the points but this did not give satisfactory indication of the accuracy of the measurements. The charge was therefore plotted against the log of the concentration and a straight line

TABLE III

Size mm.	Distance from Nozzle, cm.									Total	nd^2	nd^3
	15	25	35	45	55	65	75	85	95			
.01	31	11	12	22	15	12	7	12	9	131	0.0411	0.00041
.02	23	2	10	9	14	8	10	6	6	88	0.0878	0.00221
.03	13	2	1	9	10	9	12	5	5	66	0.1866	0.0056
.04	—	1	2	2	10	10	5	3	38	71	0.3569	0.0143
.05	9	5	10	4	14	8	1	8	46	105	0.8247	0.0412
.06	3	—	4	1	4	4	—	4	20	40	0.4574	0.0271
.07	—	—	1	2	3	5	5	12	26	54	1.0857	0.0867
.08	—	1	2	1	8	6	7	7	22	54	0.8313	0.0582
.09	—	1	—	—	—	—	6	—	9	16	0.4071	0.0367
.10	—	—	—	1	9	5	6	3	11	35	1.0681	0.1068
.11	—	—	—	—	—	2	1	—	2	5	0.1990	0.0209
.12	—	1	—	—	4	1	1	3	6	16	0.7238	0.0868
.13	—	1	1	—	—	1	—	—	3	6	0.3178	0.0414
.14	—	—	—	2	—	1	—	—	1	4	0.2463	0.0345
.15	—	2	1	3	2	—	—	—	4	12	0.8482	0.1272
								Total		703	7.6818	0.6900

$$\text{Volume} = \frac{n_1}{6}(d \times .1)^3 \text{ cc.} \quad \text{Area} = n_2(d \times .1)^2 \text{ sq. cm.}$$

$$\text{Area/cc.} = \frac{6n_2(d \times .1)^2}{n_1(d \times .1)^3} = \frac{6 \times .076818}{.00069} = 668 \text{ sq. cm./cc.}$$

was obtained (Fig. 2). This not only brought to light a very interesting relationship but it made available a check on the accuracy of the measurements. When it was found that sodium nitrate and sodium acetate also gave straight lines with the same slope (Fig. 2), but with different inter-

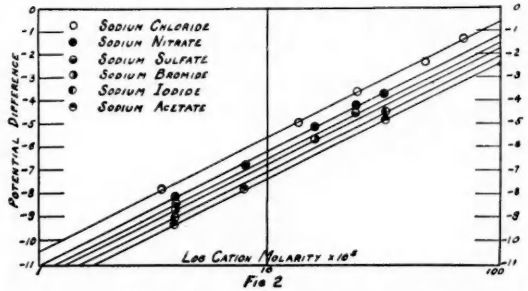

Fig 2

cepts, it seemed that the slope must be determined by some property of the cation. Curves were obtained for potassium chloride and lithium chloride (Fig. 3) and this hypothesis was substantiated by the fact that the lines had different slopes from that of the sodium lines. We have since replotted

Malarski's[24] data for KCl and Buhl's[8] data for KCl and $BaCl_2$ using the P-log c plot and have obtained straight lines for all three.

It was simply a matter of elimination to determine which of the properties of the cations might conceivably be involved and then which one or ones of these fitted the facts. It was found that the ratio of the slopes of these three lines (NaCl, KCl, LiCl) was about the same as the ratio of the reciprocals of the effective ionic radii in solution as given by Latimer, Pitzer, and Slansky.[17] They had sought to extend the Born expression to solutions of the alkali halides and, by a graphical method had determined that the addition of 0.85 Å to the accepted crystal radii of the alkali cations would give effective radii or "cavity" radii which fitted the Born expression very well. We used these augmented radii for the monovalent cations.

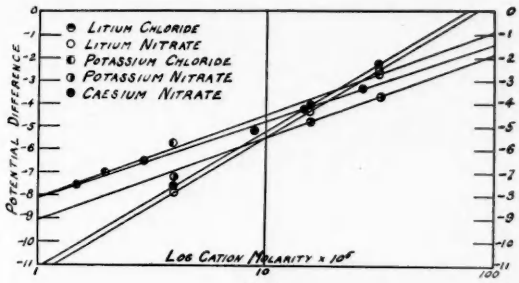

FIG 3

The slopes were NaCl, 4.90; KCl, 3.68; LiCl, 5.88. The effective radius of the sodium ion was given by Latimer, Pitzer, and Slansky as 1.80 Å which, the ratio being assumed to hold, would give 2.39 Å for potassium and 1.30 Å for lithium whereas Latimer, Pitzer, and Slansky gave 2.18 Å and 1.45 Å respectively. While these are by no means perfect checks, they indicated that we might be on the right track. We were then in a position to write an expression for the potential on the droplets. The equation of any of the straight lines was:

$$p = k \ln c + b = K \log c + b \tag{1}$$

which in the differential form is:

$$\frac{dp}{dc} = \frac{k}{c} \tag{2}$$

and this is the equation of the line which would be obtained by plotting the data on rectangular coordinates. Since the slope, K, in equation (1) is dependent on the effective radius of the cation, we could write:

$$P = \frac{a}{r_{ec}} \log c + b \tag{3}$$

where r_{ec} is the effective radius of the cation. From the slope of the lines for sodium salts the value of a was determined as 8.8 and we had:

$$P = \frac{8.8}{r_{ec}} \log c + b \tag{4}$$

Since this expression had been derived using only monovalent ions, there was a possibility that the valence of the anion might have some effect on the slope but the fact that sodium sulfate (Fig. 2) gave a line parallel to those for the salts of monovalent anions, indicated that this was not the case. In equations (3) and (4) b will be characteristic for the salt being studied. It is obvious that the general form (3) will hold for all experimental conditions but that equation (4) holds only for the particular conditions of our experiment. It is also very apparent that equation (3) can hold only over a certain range of concentration, since, when c has a value of zero, equations (3) and (4) give a value of minus infinity for P and we know that this is far from being correct. The question remains of whether there is a sloping off as the value of P for pure water is approached or whether there is a maximum. The determinations for 0.00001 M NaOAc indicate that there is a maximum but this range of low concentration needs more study.

TABLE IV

Cation	Crystal Radius Å	Increment Added Å	Calc. Effect. Radius Å	Obs. Effect. Radius Å
Na	0.95	0.85	1.80	—*
Li	0.59	0.85	1.44	1.50
K	1.33	0.85	2.18	2.39
Cs	1.69	0.85	2.54	2.60
Mg	0.71	0.70	1.41	1.36
Ca	0.98	0.70	1.68	1.70
Ba	1.31	0.70	2.01	2.00
Cr	0.65	1.74	2.39	2.42
Au	1.37	1.74	3.11	3.08

* Sodium was used as the basis for the determination of the other radii.

Determinations have been made with the salts of nine cations and each of these fits equation (4) closely. However, in the case of the divalent and trivalent cations, it is necessary to add 0.70 Å and 1.74 Å respectively to the crystal radii in place of the 0.85 Å added for the monovalent cations by Latimer, Pitzer, and Slansky.[17] So far as we have been able to find, this gives the first indication of the effective sizes of the divalent and trivalent cations in solution. The P-log c curves are given in Figs. 2, 3, and 4 and the calculated and observed effective radii are given in Table IV. In cases where agreement is not so close as might be hoped, the discrepancy may be due to inaccuracies in our measurements but it must also be remembered that the effective radii of the ions are not accurately known and that our measurements may indeed prove to be the most satisfactory way of measuring them once a standard (say the sodium ion) has been established. It is also possible that the controlling factor is some property closely related to the effective radius, such as the deforming power or deformability.

It is interesting that the divalent and trivalent cations fit the expression as well as the monovalent cations from which we must draw one of two conclusions: either the charge of the ion has no effect on the slope or there is some force in the solutions which reduces the effective charge of all the cations to the same value. We are not prepared to say that the latter is not

possible but there is considerable evidence against it. Although we have found chromium chloride obeying equation (4) as well when P has a positive sign as when it has a negative sign, and have found that this is not so for sodium chloride which shows a break in the curve at 0.00069 M, we are not

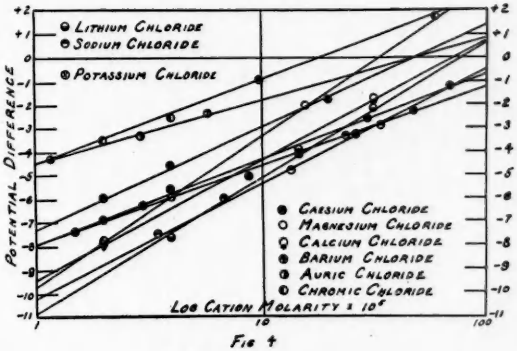

Fig 4

prepared to say that the sign may never reverse with monovalent cations until more work has been done at higher concentrations. This is what we would expect if the effect of the dissolved cations is to "cover" the negative charge previously existing. The most that any monovalent cation could do would be to neutralize the existing charge while a polyvalent cation might reverse it. This point deserves a more careful investigation but in the meantime we shall have to conclude that the charge of the cation has no effect on the slope.

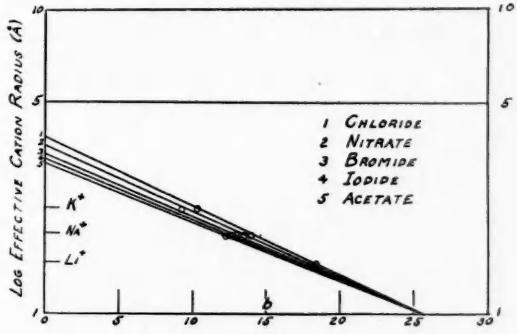

Fig 5

The question "What determines the value of b in equations (3) and (4)?" is not so simple. Obviously it is affected by some property of the anion since different salts of the same cation have different intercepts. Since the values of b fall in approximately the same ratio as the reciprocals

of the effective anion radii, it seems probable that there is some relation similar to that between the effective cation radii and the slopes. That the cation radius also has some effect can be shown by plotting the value of b against the log of the effective cation radius. With salts of sodium, lithium, and potassium, straight lines are obtained for each anion and the lines have a common intercept. These lines are shown in Fig. 5. Salts of the divalent and trivalent cations do not fit these lines which indicates that the charge of the cation also has some effect on b but at the present time we have not been able to determine this relationship.

From the lines for monovalent cations we get an expression similar to that for P:

$$b = K \log r_{ec} + f \tag{5}$$

but, since the slope of these lines is determined by the effective radius of the anions (r_{ea}), we can write:

$$b = d\, r_{ea} \log r_{ec} + f \tag{6}$$

in which the values of d and f have been determined by substitution for the monovalent cations and are — 22.4 and 25.4 respectively. This gives a total expression for P in the case of the monovalent cations:

$$P = \frac{8.8}{r_{ec}} \log c - 22.4\, r_{ea} \log r_{ec} + 25.4 \tag{7}$$

This expression is only an approximate one and will certainly need modification before it will be applicable to polyvalent cations. The necessary modifications can only be made when more data are available. Using equation (7) we have calculated the sizes of the anions with the results shown in Table V. In the case of the NO_3^- ion the "actual" effective radius listed

TABLE V

Anion	Actual Effective Radius Å	Calculated Radius Å
Cl	1.91	—*
NO_3	2.04	2.01
Br	2.05	2.09
SO_4	2.20	2.08
I	2.30	2.17

* The chloride ion was used as the basis for the determination of the other radii.

in Table V was determined by adding together the N–O distance, the radius of the oxygen atom, and the correction increment, 0.1 Å, suggested by Latimer, Pitzer, and Slansky.[17] This can be expected to give an approximation at best. A similar procedure was followed for the SO_4^- ion.

Theoretical Considerations

There have been many attempts to explain the mechanism of this and related phenomena but so far none has been entirely satisfactory. Of the more recent explanations, the one which seems to have been most widely accepted is that due to Lenard [18, 19, 20] and modified by Buhl.[4, 5, 6, 7, 8] They

conceive of a double layer lying entirely within the liquid phase with the negative side on the outside. They suggest that, when small droplets are torn from the surface, they take only part of the negative section of the double layer and hence they carry a negative charge. They explain the presence of positive electrical carriers by the tearing off of droplets from layers lying below the surface in the positive part of the double layer and exposed by previous tearing off of part of the negative layer. They believe the effect of added electrolytes is due to their neutralization of the double layer which cuts down the number of negative carriers formed when the surface is torn apart. Aside from the question of whether or not there may be an electrical double layer lying entirely within the liquid phase, their explanation seems incompatible with our results and with the results of all other workers who have measured the net effect. Both Lenard and Buhl studied the mobilities of the electrical carriers produced and found more negative than positive carriers in most cases which is perfectly understandable in the light of their theory but the *net* effect must be zero since the liquid was electrically neutral to start with, and the positive and negative carriers, meeting on the surface of the measuring device, would neutralize each other.

It seems that there might be a way of explaining the presence of a net negative charge by supposing that free electrons in the gas neutralize the positive charge. This explanation falls down, however, in the case where the positive carriers predominate and there is a net positive charge.

We have here used the term "charge" rather loosely. Whatever the mechanism of the effect may be it manifests itself as a potential difference. As we shall point out again a little later we consider at present that the electrification is accomplished by a transfer of electrons and, in thinking about the effect of such a transfer, the term charge is more convenient than the more strictly correct potential difference.

Equation (7) seems to hold reasonably well for salts of monovalent cations and it seems probable that equation (4) could be modified in some way to a form similar to equation (7) so that it would apply to salts of divalent and trivalent cations but beyond this we are not prepared at present to suggest a full theoretical interpretation of the effect. However, from our own work and from the apparently reliable observations of some previous workers, we might suggest some conditions to which any theoretical explanation will apparently have to conform.

1. Ballo-electricity (to use Christianson's [12] name for the phenomenon) is a surface phenomenon and occurs only on the rupture of an interface. That an interface is necessary was shown by Faraday [14] who found that water vapor shot through a jet onto a target acquired no charge until a small amount of liquid water was introduced in the form of droplets. Many workers have shown that there is no charge developed if the liquid surface is not ruptured.[1, 3, 18, 23, 38]

2. The phenomenon cannot be simply a separation effect between the components of the double layer since, if this were so, the net effect would be zero due to the recombination of the negative and positive carriers on the collector.

3. Since only polar liquids produce the effect, as has been shown by Buhl [8] and others, the orientation of solvent molecules in the surface must be involved.

4. The addition of electrolytes probably affects the orientation of dipoles in the surface and thus controls the ballo-electric effect.

5. Cations seem to have two effects: the more important is due to their size which affects the rate of change of potential with concentration, and the other, due to their electrical properties, influences the intercept of the P-log c curve.

6. The anions seem to have only one effect which is due to their size.

7. It seems probable that the mechanism of the phenomenon is a transference of electrons from the gas to the liquid and from the liquid to the gas as the case may be. Any other explanation requires the postulation of positive ions being carried away by the gas, which is hard to imagine.

Summary of Conclusions

1. It has been possible to measure quite accurately the potential difference between the ground and small droplets of water or aqueous solutions sprayed from an atomizer.

2. The potential has a negative sign for pure water.

3. Very small amounts of electrolytes make the potential more negative but slightly larger amounts reduce the negative potential below the value for pure water.

4. In our experience, the sign has been reversed for chromium chloride but never for any salt of a monovalent cation.

5. If the potential is plotted against the log of the concentration of cation, a straight line is obtained in each case.

6. The slope of the P-log c lines depends only on the effective radius of the cation in solution or on some closely related property of which the values for various cations bear approximately the same ratio as the effective radii.

7. To obtain the effective radii in solution of divalent and trivalent cations it is necessary to add approximately 0.70 Å and 1.74 Å respectively to the crystal radii in the same way that Latimer, Pitzer, and Slansky suggested adding 0.85 Å for the monovalent cations.

8. The electrical properties of the cations have some effect which is not fully understood at present.

9. The size of the anions affects intercepts of the P-log c lines but the electrical properties apparently have no effect.

10. The explanation of the effect as a separation of the components of the double layer has been shown to be untenable.

11. It has been suggested that the mechanism of the phenomenon consists of the transfer of electrons between the liquid and gas phases.

12. This work indicates that ion size is probably of significant importance in the coagulation and dispersion of colloidal systems by electrolytes.

13. The potential difference at the liquid-gas interface has been found to be too small to be of practical importance in textile mill waste treatment.

Appendix A.—Suggestions for Improvement

EXPERIENCE has shown that the apparatus might be improved by some changes. The most important aim of these changes would be to remove as far as possible the effect of outside influences which tend to make balancing of the electrometer difficult. The chief change would be the re-

moval of the tube from the electrometer housing and its placement in a separate housing under the tray. The tube would then be connected with the rest of the electrometer by a shielded cable.

This would allow the trays, sprayer, and electrometer tube to be placed at a considerable distance (say 10–15 feet) from the rest of the apparatus and to be surrounded by a grounded wire cage.

It might also be advantageous to have the spray collected in a metal lined box rather than on a tray. Less spray would be lost in this way. However the box would have to be large enough to preclude any large amount of splashing which would introduce a related but not necessarily identical phenomenon.

These changes, by lessening the effect of outside influences and by reducing the time required for the electrometer to reach its maximum reading, should materially reduce the difficulty of balancing the electrometer and keeping it in balance long enough to take a reading.

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Obituary

Dr. Joseph F. X. Harold, who died Jan. 3 at the Hospital for the Ruptured and Crippled, New York City, was an original member of the Institute, a charter member of the American Association of Textile Chemists and Colorists, and one of the founders of the American Association of Textile Technologists. Born in Philadelphia Aug. 11, 1874, he was graduated from La Salle College in 1892, and later received from University of Pennsylvania degrees of B.S. and Ph.D. He taught chemistry and physics at Villanova College from 1896 to 1897, and for the next eight years was professor of chemistry at the Philadelphia Textile School. Since 1911 he had been associated with Dr. W. M. Grosvenor and the Grosvenor Laboratories. He was the author of many technical papers, and held many textile chemical patents. He will be missed and ever remembered by a host of friends for his genial personality and his technical ability. He is survived by his second wife, five sons and four daughters.

Abstracts

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Cellulose: Recently Developed Sources of. L. G. S. Hebbs. *J. Soc. Dyers Col.*, Nov. 1929, P. 550–9. (C)

Electrophoretic Studies of Wool. Arnold M. Sookne and Milton Harris. *Text. Rsch.*, Oct. 1939, P. 437–43; *N. B. S. J. Rsch.*, Oct. 1939, P. 471–7; *Am. Dye. Rptr.*, Oct. 2, 1939, P. 593–6.

A new investigation of the electrophoretic properties of wool shows that phthalate ion, used in buffers in earlier work, exhibits a specific ion effect, and shifts the isoelectric point to lower pH values. In acetate buffers, the isoelectric point of wool scales and cortical cells was found to be at pH 4.5. Samples of ground or powdered wool show an isoelectric point at pH 4.2. Much of the confusion which exists concerning the location of the isoelectric point has arisen from the assumption that the isoionic and isoelectric points are identical. The significance of both of these points in wool processing is discussed. (C)

Fibres: Natural and Synthetic. H. Staudinger. *Mell. Textilber.*, 1939, No. 9, P. 631–5.

The most diverse theories have been advanced to account for the special strength of the structure of natural cellulose and protein fibres, and many authorities were of the opinion that it was the result of the process of

growth, or was based, in other words, on a biostructure. The author, however, holds that the real reason is the chemical structure of the fibres. It was demonstrated as far back as 1927 that it is possible to obtain a fibre with a structure similar to that of natural cellulose fibres by the treatment under definite conditions of polyoxy-methyl compounds, the macromolecular structure of which had been proved by the methods adopted. The crystallites are disposed in a definite arrangement about the axis of the fibre. The author finally deals with synthetic fibres. Thus chlorinated polyvinyl chloride can be spun into fibres from its solution in organic solvents. The fibres prepared in that way, known in Germany as PC fibres, are thus made from coal and common salt. Synthetic fibres have recently also been prepared according to Carothers, which represent polycondensation products from glycols and dicarbonic acids. These fibres possess an extraordinarily high breaking strength and elastic elongation. (C)

II. Yarns and Fabrics

Bleaching Time: New Non-kier Boil Method Reduces. Anon. *Daily News Record*, July 14, 1939, P. 11.

Describes a three-hour continuous method for bleaching cotton piece goods which uses one reagent for removal of waxes and starches, and another for removal of motes and shives. (C)

Carbonizing Practice. L. Bonnet. *Teintex*, 1939, V. 4, P. 204–11; abs. in *J. T. I.*, July 1939, P. A466.

The advantages and disadvantages are stated of carbonizing with sulphuric acid, sodium bisulphite, acid calcium phosphate, hydrochloric acid, aluminium chloride, magnesium chloride and various proprietary products. Methods are described for carbonizing loose wool, wool waste and rags and for piece carbonizing. Problems discussed are piece carbonizing before and after scouring, after milling and after dyeing. (C)

Cellulosic Textile Industry: Trend of Progress in. H. A. Thomas. *Text. Mfr.*, Aug. 1939, P. 338–9, 357.

A summarized discussion of the chemical, physical, and physico-chemical discoveries in the field of cellulose which are playing an important role. (C)

Certified Climate in Worsted Mills. *Parks' Parables*, Oct. 1939.

Controlled humidity in worsted manufacturing, and the resulting benefits as analyzed and measured by their effect upon quality of product and reduced cost of production. (C)

Cloth Shrinkage: Effect of Yarn Twist and Tension on—with Particular Reference to Sanforizing. Wm. H. Harriss. *Text. Bulletin*, Nov. 15, 1939, P. 26, 39, 50. (C)

Cotton Broadcloth: Consumer Classification and Specifications for. Gladys White and Margaret B. Hays. *Am. Dye. Rptr.*, Aug. 7, 1939, P. 410, 431–6, 439.

Cotton Fabrics: Effect of Weave on Structure. P. Kober. *Mell. Textilber.*, 1939, V. 20, P. 337–42. (C)

COTTON YARNS: EMPIRICAL RELATIONSHIPS BETWEEN COUNT, TWIST AND STRENGTH OF. PART I. COUNT—SINGLE THREAD STRENGTH. PART II. TWIST—STRENGTH. Nazir Ahmad and V. Venkataraman. Indian Central Cotton Committee Tech. Lab., *Technological Bulletin*, Series A, No. 48, June 1939; *Text. Mfr.*, Oct. 1939, P. 432–3, 445. (C)

CRIMP IN RAYON STAPLE FIBRE: ITS CREATION AND RETENTION IN SPINNING. *Rayon Text. Mo.*, May 1939, P. 51–2. (C)

DETECTION OF HARD IMPURITIES IN FIBROUS MATERIALS. T. Merchant. *Text. Mfr.*, Sept. 1939, P. 399.

Various arrangements of electro-mechanical detector mechanism which have been successfully applied to detecting and removing hard metallic or other impurities in fibre on opening, carding, and similar machines. (C)

DRYING CYLINDERS: MEASUREMENT OF CLOTH TEMPERATURE AND MOISTURE CONTENT. S. Makarin. *Legkaja Prom.*, 1938, V. 17, No. 4, P. 96–102 (through *Chem. Zentr.*, 1939, i, P. 288); abs. in *J. T. I.*, July 1939, P. A465.

An apparatus for measuring the temperature of cloth as it comes off the drying cylinders, or of the cylinders themselves, depends on measuring the heat radiated and the application of the Stefan-Boltzmann equation. By experiment the author has established a direct relation between cloth temperature and moisture content when the temperature and humidity of the air are constant. (C)

FAULTS (IN WOOL FABRICS) CAUSED BY FIBRE MOVEMENT. *Wool Rec. & Text. Wld.*, June 8, 1939, P. 1268–9.

In a number of wool cloths the operations of preparing, dyeing and finishing cause the coarser fibres to project on to the surface of the fabric to such an extent that they constitute a defect. Methods of prevention and correction are given. (C)

FELTS: USE OF CASEIN IN. *Wool Rec. & Text. Wld.*, Aug. 3, 1939, P. 245–7.

Its advantages and disadvantages are discussed. (C)

FIBRES: NEW. F. Bonnet. *Canadian Text. J.*, Nov. 24, 1939, P. 43–5.

Recent developments in strong rayon, staple fibre, casein fibre, Nylon and Vinyon in the textile field, as described by the author in an address to the Eastern Section, Textile Society of Canada, Nov. 1939. (C)

FINISHING WOOLENS AND WORSTEDS. G. L. Atkinson. *Text. Mfr.*, Aug. 1939, P. 364.

Safe and economical scouring as determined by the stains to be removed. (C)

FINISHING YARN DYED WORSTEDS. G. L. Atkinson. *Canadian Text. J.*, Sept. 1, 1939, P. 31–2.

Advice on essential operations to preserve color and obtain satisfactory fabric appearance and handle. (C)

FLAX AND COTTON INDUSTRY. C. G. Worthington. *Am. Wool & Cotton Rptr.*, May 11, 1939, P. 21–2.

Summary of experimental work on the preparation of flax fibre and its processing on cotton machinery. (C)

IRON STAINS ON WOOL. *Wool Record & Text. Wld.*, Sept. 28, 1939, P. 654–5.

Describes the causes of these faults and their detection and removal. (C)

KAPOK-STAPLE FIBRE MIXTURES: SPINNING. A. Lambrette. *Rusta*, 1939, V. 14, P. 81–4; abs. in *J. T. I.*, May 1939, P. A309.

The characteristics of kapok, especially its behavior when subjected to compression and on dyeing, are described and difficulties encountered in attempts to spin this fibre are pointed out. The possibilities of spinning mixtures of kapok and other fibres are discussed. Mixtures with staple fibre appear to be the most promising. Some suggestions in regard to procedure are made. (C)

III. CHEMICAL AND OTHER PROCESSING (NOT OTHERWISE CLASSIFIED)

DYEING OF NYLON FIBRES. P. H. Stott. *Am. Dye. Rptr.*, Oct. 2, 1939, P. 582–90.

Summarizes experimental work done to date on the dyeing of Nylon to ascertain the most suitable colors evaluated from the standpoint of applicability and certain fastness properties. Much of the data presented is in the form of lists of dyestuffs identified by name and Color Index number showing the affinity of these dyestuffs for Nylon and their adaptability for the fibre in various forms. The paper includes discussions on the most suitable dyestuffs found so far for the dyeing of hosiery and yarn based on semi-practical trials, and indicates possibilities of cross-dye effects between Nylon and other textile fibres. (C)

DYEING PROPERTIES OF NEW FIBRES. H. M. Bunbury. *J. T. I.*, July 1939, P. P172–80; *Text. Mfr.*, June 1939, P. 272–3.

The discussion of dyeing properties is confined almost entirely to the new fibres as such, the object being to give a general picture of these fibres as they appear to the dyestuff manufacturer rather than to discuss the more complicated problems presented by the admixture of these fibres either with the standard fibres or with one another. (C)

DYES: DEGREE OF AGGREGATION OF—IN DILUTE SOLUTION. C. Robinson and H. E. Garret. *Trans. Faraday Soc.*, 1939, V. 35, P. 771–84; abs. in *J. Soc. Dyers Col.*, Nov. 1939, P. 588. (C)

DYESTUFFS: STUDIES IN THE FLUORESCENCE OF. S. B. Sen-Gupta. *J. Indian Chem. Soc.*, May 1938, V. 15, P. 263–300; abs. in *Eastman Kodak Abs. Bull.*, May 1939, P. 295.

The fluorescence and extinction coefficients of a number of dyes in alcoholic solutions were studied. The absorption capacity per molecule in-

creases with dilution up to a certain limit after which Beer's law is obeyed. The maximum fluorescence yield for fluorescein at 365 $\mu\mu$ is about 0.72. The experimental results confirm the general observation that the fluorescence yields remain constant up to a limiting concentration, beyond which the yields fall off with increase in concentration. The fluorescence yields are found to be roughly proportional to the wave lengths of exciting light. The molecular conductivities (in aqueous alcohol), when plotted against the square root of concentration, do not give a linear relationship, even at 0.01 M, as is to be expected from the Debye-Hückels theory. Mechanisms for quenching of fluorescence are discussed. (S)

ESTERS OF SODIUM SULPHOSUCCINIC ACID (WETTING AGENTS). C. R. Caryl and W. P. Ericks. *Ind. Eng. Chem.*, 1939, V. 31, P. 44–7.

The theory of surface active compounds is briefly reviewed and the conditions which a satisfactory commercial wetting agent must fulfill are stated. The wetting properties of over 100 commercially available wetting agents have been determined by the Draves Test. Dioctyl sodium sulphosuccinate (Aerosol OT) is the most effective agent examined by this test. Graphs illustrating the effect of acids and alkalis on the wetting properties of certain of the more important agents are appended. (C)

FILM CONTINUITY OF SYNTHETIC RESIN COATINGS. G. H. Young, G. W. Gerhardt, W. K. Schneider, and G. W. Seagren. *Ind. Eng. Chem.*, 1939, V. 31, P. 719–21.

By means of an electrical method it is shown, using methyl-, propyl- and butyl-methacrylate and vinyl acetate and chloride polymers, that the coating weight required just to produce continuity, apparently varies inversely with the chain length and directly with the effective polarity. (C)

FINISH: EFFECT OF —ON SHADE OF DYED COTTONS. *Text. Mfr.*, Aug. 1939, P. 362–3.

Matching of dyed shades is complicated by the effect of finishing agents or processes which should be standardized where they cannot be eliminated. (C)

FIXATION OF BASIC COLORS WITH TANNIN BY SIMPLE STEAMING WITHOUT PASSING THROUGH TARTAR EMETIC. Soc. Manuf. Emile Zundel (Moscow) and S. M. Jones. Sealed Communication No. 2205 of Sept. 10, 1912. *Bull. Soc. Ind. Mulhouse*, 1939, V. 105, P. 186–9; abs. in *J. Soc. Dyers Col.*, Sept. 1939, P. 472.

Basic dyes, tannin and tartar emetic may be applied to the fibre in a single operation, and the color fixed subsequently by simple steaming, without the usual subsequent treatment in a bath of tartar emetic, by adding a solvent for the triple lake of dye, tannin and antimony and so retarding its precipitation. A mixture of phenol and resorcinol, in presence of a little tartaric acid, has proved most successful for use as a solvent. The printed material is dried, steamed and soaped. On account of the perfect penetration of the fibre, the resulting prints are very bright and particularly fast to soap. A. Musculus confirms the above and adds that this process

has priority over, and gives superior results to, that of N. Wosnessensky (*Bull. Soc. Ind. Mulhouse*, 1924, *80*, 367). (C)

GEL STRUCTURE OF FIBRES: MIGRATION OF SUBSTANTIVE DYES INTO RAYON FIBRES, IN COMPARISON WITH THE BEHAVIOR OF DYE SOLUTIONS AND THE. W. Weltzien and H. Froitzheim. *Seide u. Kunstseide*, 1939, V. 44, P. 185–90, 238–45, 269–75, 314–22; abs. in *J. Soc. Dyers Col.*, Oct. 1939, P. 522. (C)

INDIGO BLUE VAT: INDIGO CONTENT DETERMINATION. J. Lotichius. *J. Soc. Dyers Col.*, 1939, V. 55, P. 87–8.

A colorimetric method for the determination of the indigo in blue vats is described which depends on the formation of a blue sol when sodium protoalbinate is added to an alkaline solution of leuco-indigo and the latter oxidized with hydrogen peroxide. The color is then compared with that of a standard solution of known indigo content. (C)

MERCERIZATION OF COTTON-STAPLE FIBRE MIXTURES. L. Kollmann. *Seide u. Kunstseide*, 1939, V. 44, P. 228–31; abs. in *J. Soc. Dyers Col.*, Sept. 1939, P. 473.

Investigation of the influence of various conditions, *e.g.*, concentration of the caustic soda lye, its temperature, duration of action, effect of addition of wetting agents to the lye, and the tension employed, on the mercerization of yarn consisting of 80% cotton and 20% viscose staple fibre, has indicated that 23° Tw. caustic soda is most injurious and that, with ordinary care, no appreciable injury of the staple fibre occurs when a lye of normal mercerizing strength is used. Addition of a mixture of salt and a wetting agent is more beneficial than either of these alone. Higher temperatures, *e.g.*, 40–50° C., are unfavorable to the production of the maximum lustre on cotton, but are necessary to maintain the tenacity of the staple fibre. When all necessary precautions are taken, prolonging the duration of the action of the lye does not diminish the strength of the staple fibre materially. Special attention must be given to tension, because even tension insufficient to maintain the original length results in damage to the staple fibre. Rinsing is best carried out at about 50° C., preferably with addition of salt to the rinsing water. As regards lustre, it is concluded that, in the interests of the tenacity of the staple fibre, mercerization should be carried out with warm lye and without too great tension, although these conditions do not impart the maximum degree of lustre to the cotton. Thus, in mercerizing cotton-staple fibre mixtures the lustre of the cotton is scarcely increased, while the lustre of the staple fibre is more or less diminished. (C)

MORDANTING WOOL IN THE COLD. J. M. Gaudit. *Rev. gén. mat. color.*, 1939, V. 43, P. 18 (through *C. A.*, 1939, V. 33, Col. 2343); abs. in *J. T. I.*, May 1939, P. 324.

Amend's process, which is economical because of eliminating the cost of steam treatment, consisting of a bath of 5% sulphuric acid, 1% potassium bichromate and, after exhaustion, an addition of 5% sodium bisulphite, is modified to 2.5% formic acid for 10 min., to which is added 1% sodium bichromate; this is followed by the bisulphite. It is claimed the fibre treatment is less harsh. (C)

MOULD FORMATION: PROTECTION OF TEXTILE FIBRES BY PREVENTION OF. A. Foulon. *Deut. Wirker-Ztg.*, 1938, V. 58, No. 41, P. 10–11 (through *C. A.*, 1939, V. 33, Col. 1948); abs. in *J. T. I.*, May 1939, P. A325.

A discussion of the use of *p*-chloro-*m*-cresol, which is soluble in water and economical to employ and which does not alter the pH of the textile material. (C)

OXIDIZING AGENT FOR TREATMENT OF TEXTILES: NEW. A. L. Dubeau, J. D. MacMahon and G. P. Vincent. *Am. Dye. Rptr.*, Oct. 2, 1939, P. 590–2.

Describes the properties and uses of Textone (Mathieson Alkali Works). Although the oxidizing value of Textone, when calculated as available chlorine, is approximately 130%, unlike sodium hypochlorite it liberates chlorine dioxide (ClO_2) when acidified rather than free chlorine whose destructive action on cellulose is only too well known. (C)

IV. RESEARCH METHODS AND APPARATUS

IDENTIFICATION OF THE NEWER TEXTILE FIBRES. John H. Skinkle. *Am. Dye. Rptr.*, Nov. 27, 1939, P. 694–5.

The fibres for which methods of identification are given are glass fibre, casein wool, mixtures of viscose and casein of the cisalfa type, nylon, and the vinyl resin type. (C)

LANITAL: DETERMINATION OF—IN TISSUES MIXED WITH WOOL. A. Cappelli and R. Tuffi. *Annali Chim. Appl.*, 1938, V. 28, P. 399–405, 530–36 (through *Brit. C. A., B*, 1939, V. 58, P. 250, 469); abs. in *J. T. I.*, 1939, May, P. A341; July, P. A484.

The tissue is treated with 6-vol. hydrogen peroxide for 15 min. at 60° and then with 10% caustic soda at 35° for 1 hr. The wool is dissolved, and the lanital is filtered off, washed, dried, and weighed. (C)

MOISTURE IN WOOL AND WOOL FABRICS: RAPID DETERMINATION OF. A. Matetskii. *Sherstyanoe Delo*, 1938, V. 17, P. 34–9 (through *C. A.*, 1939, V. 33, Col. 2721); abs. in *J. T. I.*, July 1939, P. A484.

The method is based on deducing the moisture content from the variations in the dielectric constant of the material. The device used for this purpose must be provided with two scales so as to be able to increase the sensitiveness when low moisture contents are determined, because the same abstract change in moisture content has much less effect on the dielectric constant of fabrics with low than with high moisture content. Treatment of woolens with dilute sulphuric acid increases considerably the dielectric constant; after washing with water and neutralization with 2% sodium carbonate solution, the original value is restored. (C)

MULLEN BURST TEST: INCREASING THE ACCURACY OF. Mark N. Holmes. *Text. Age*, Nov. 1939, P. 41–2.

To prevent rupturing or weakening of the rubber diaphragm of Mullen Burst Testers when stretchy materials, such as woven crêpe fabrics and fine gauge hosiery, are tested, a moveable mount on the diaphragm nut has been devised which imparts uniform tension to the fabric under test. Another device has been added which makes possible comparative fatigue tests. (C)

pH: Control of—in Peroxide Solutions. J. S. Reichert and H. G. Hull. *Ind. Eng. Chem., Anal. Ed.*, 1939, V. 11, P. 311–3.

Many colorimetric indicators are affected by oxidizing agents, but with a proper choice of indicators, colorimetric methods can be satisfactorily applied in many cases. The glass electrode is particularly well adapted for potentiometric pH measurements in oxidizing and reducing systems and is suitable for determining the pH of peroxide solutions. The agreement between colorimetric and potentiometric determinations for clear, colorless hydrogen peroxide solutions is usually within 0.4 units. Hydrogen peroxide behaves as a weak acid and increases the hydrogen on activity of sulphuric acid in proportion to the peroxide concentration; at constant concentration of sulphuric acid, the observed pH decreases as the peroxide concentration increases. (C)

Photo-electric Photometric Devices: Application. R. H. Müller. *Ind. Eng. Chem., Anal. Ed.*, 1939, V. 11, P. 1–17.

A review is given of the applications of photo-electric photometry in chemical analysis and process control, with a bibliography of 239 references and a list of special monographs in the fields of optics and electronics. (C)

Photomicrography and Record Photography with Dufaycolor. S. R. Wycherley. *J. Roy. Microscop. Soc.*, December 1938, V. 58, P. 244–49; abs. in *Eastman Kodak Abs. Bull.*, August 1939, P. 423.

A brief general discussion of the various available processes of additive screen color photography, with the advantages and the disadvantages of each, is given. The author then describes, in some detail, the Dufaycolor process, which he regards as best suited to photomicrography, taking into consideration the light source, the optical system, manipulation of material (with formulas), and the exposure determination. (S)

Photronic Brightness Tester, Opacimeter and Gloss Meter. Stanley W. Blanchard. *Paper Trade J.*, Aug. 31, 1939, P. 29–30.

The development of a brightness meter, an opacity meter and experiments in measuring gloss of pulps and papers are described. The combining of all these functions in one instrument is discussed. (C)

Physical and Chemical Tests for Staple Fibre. Walter Schieber. *Mell. Textilber.* (German edition), 1939, No. 9, P. 617. (C)

Plastic for Embedding. A. Ball. *Brit. Plastics*, December 1938, V. 10, P. 351–52; abs. in *Eastman Kodak Abs. Bull.*, May 1939, P. 300.

A transparent urea-formaldehyde plastic in the form of a honey-like liquid, "Einbettmasse HFK," has been introduced by I. G. Farbenindustrie A.-G. When mixed with a small proportion of a suitable coagulant (the nature of which is not divulged), it sets in a few hours to a transparent elastic mass. Plants, insects, anatomical specimens, etc., are preserved by embedding them in the liquid and allowing it to set. (S)

Rayon and Staple Fibre: Determination in Mixture Fabrics. (1) L. Hofmann. (2) A. Schejnoha. *Zellwolle*, 1939, V. 5, P. 48–50; abs. in *J. T. I.*, May 1939, P. A341. (C)

SLIDE RULE: DIRECT READING—FOR ELIMINATION OF CALCULATIONS IN REGAIN DETERMINATIONS OF HYGROSCOPIC MATERIALS. S. G. Barker. *J. T. I.*, Aug. 1939, P. 131–2.

By its use in practical work the determination of regain after initial weight and dry weight are ascertained becomes a simple mechanical routine. The slide rule was made by C. F. Caella & Co. Ltd., to the author's instructions. (C)

SLING HYGROMETER: RAPID CALCULATION OF RELATIVE HUMIDITY FROM READINGS OF THE. A. J. Turner. *Nature*, 1939, V. 143, P. 897; abs. in *J. Soc. Dyers Col.*, Sept. 1939, P. 475. (C)

V. PURE SCIENCE, ECONOMICS AND MISC.

PROTEINS: SURFACE ACTIVITY. H. Neurath and H. B. Bull. *Chem. Reviews*, 1938, V. 23, P. 391–435; abs. in *J. T. I.*, May 1939, P. A352. (C)

RAYON—AND AIR CONDITIONING. R. H. Brown. *Rayon Text. Mo.*, 1939, Aug., P. 50–2; Sept., P. 84–6. (C)

SILK FILAMENT: FORMATION. K. H. Meyer and J. Jeannerat. *Helv. Chim. Acta*, 1939, V. 22, P. 22–30; abs. in *J. T. I.*, July 1939, P. A491. (C)

SILK SOLUTIONS: FORMATION AND VISCOSITY. C. Miyahara. *J. Agric. Chem. Soc. Japan*, 1939, V. 15, P. 87–92, 93–8 (through *Brit. C. A.*, 1939, *B*, P. 301); abs. in *J. T. I.*, July 1939, P. A495.

(1) The dispersion of tussah and Bombyx silk in various reagents is described. Dispersion of tussah silk increases with rise of temperature, and with time up to 50–60 hours when it is at a maximum. Refined tussah silk is more readily dispersed than raw silk and "bleached silk," produced by the application of peroxide in reeling, is more easily dispersed than grey silk made by the old plate-reeling method. (2) The rate of increase of viscosity is much greater at high than at low concentrations in Ca thiocyanate solutions. The viscosity-concentration constant of dispersed tussah silk is greater than that of Bombyx silk. Viscosity decreases with rise in dispersion temperature, gradually increases after the first few hours, attaining a maximum after 1–2 days, and then slowly decreases. Additions of phenol, *a*-naphthol, urea, glucose, sucrose, glycerol, glycine or *l*-leucine increase the viscosity. (C)

SOLUBLE STARCH: VISCOSITY TEST. W. A. Richardson. *Chem. and Ind.*, 1939, P. 464–5; abs. in *J. T. I.*, July 1939, P. A485.

Soluble starches may be conveniently characterized by their "thiocyanate viscosities," $(I/c) \log \eta\nu$, where $\eta\nu$ is viscosity of a solution of the starch in Ca thiocyanate relative to that of the solvent (30 gm. Ca thiocyanate per 100 cc.) and c is concentration in gm. per 100 cc. The viscosities are independent of the concentration over the range 0.6 to 1%, are not influenced by the presence of small amounts of electrolytes, and remain fairly constant for many days, and provided the solution and control are tested at the same temperature there is little difference in the results over the range 25 to 60° C. Particulars are given of the preliminary treatment of the starch and its dissolution in the thiocyanate. (C)

(*Continued from Page 148*)

Earl Constantine, president, National Association of Hosiery Manufacturers, and a director of the Institute, was honored recently by election as president of the American Trade Association Executives.

* * *

Claudius T. Murchison, president, Cotton-Textile Institute, lectured recently at Western Reserve University, Cleveland, O., and in the forum period that followed is reported to have expressed the opinion that "research for new uses holds the greatest promise for solution of the cotton problem."

* * *

Sylvan I. Stroock, president of S. Stroock & Co., Inc., Newburgh and New York, N. Y., has produced a book, entitled "Stroock's Animal Kingdom," that is as novel in its artistry and its versification as the raw materials and products of his mill are unusual. Humor and cold fact are embodied in the verses and illustrations dedicated to the vicuna, llama, alpaca, camel, suri, misti, huarizo, guanaco, etc.

* * *

Fred A. Mennerich announces the opening of a new laboratory, 42 Roosevelt Ave., Jersey City, N. J., devoted exclusively to the microscopical investigation of routine and research problems in the textile field, including photomicrography. Mr. Mennerich is a graduate of the University of Wisconsin and a Fellow of the New York Microscopical Society of which he has been secretary for three years. Much of his present experience in the textile field was gained at the United States Testing Co., where he was chief microscopist for four years.

* * *

Edward R. Schwarz, professor of textile technology, Massachusetts Institute of Technology, Cambridge, Mass., is conducting an eight-weeks' course on optical analysis of textile fibres, yarns and fabrics. It is held Wednesday evenings at M. I. T., having started Jan. 24, and is given under the auspices of the Division of University Extension of the Massachusetts Department of Education. The course is offered in anticipation of a laboratory course to be given under the same auspices later in the year.

* * *

Notable papers were presented at the annual convention of the National Retail Dry Goods Association in New York City the week of Jan. 15 by the following authorities: Ephraim Freedman, director of Macy's Bureau of Standards, on "What Chemistry is Doing in the Development of New Merchandise"; Dr. Harold DeWitt Smith, treasurer, A. M. Tenney Associates, on "Prevention of Fading of Acetate Colors by Special Finishes"; Alexis Sommaripa, manager fabric development, Rayon Division, E. I. du Pont de Nemours & Co., "Studies of Efficiency in Consumption of Merchandise"; Dr. D. H. Powers, Röhm & Haas Co., "The Use of Synthetic Resins for Finishing Textile Fabrics"; E. M. Edgerton, Pacific Mills, "Test-Fast Color Standards Adopted by the National Association of Finishers of Textile Fabrics."